

The Program *Matter and the Universe*

Elementary Particle and Astroparticle Physics at DESY

Helmholtz Program: Matter and the Universe (MU)

PoF III Topics: Fundamental Particles and Forces, Matter and Radiation from the Universe

DESY Research Units: Experimental Particle Physics, Theoretical Particle Physics, Astroparticle Physics

Joachim Mnich

Center Evaluation DESY, 5 – 9 February 2018

HELMHOLTZ RESEARCH FOR
GRAND CHALLENGES

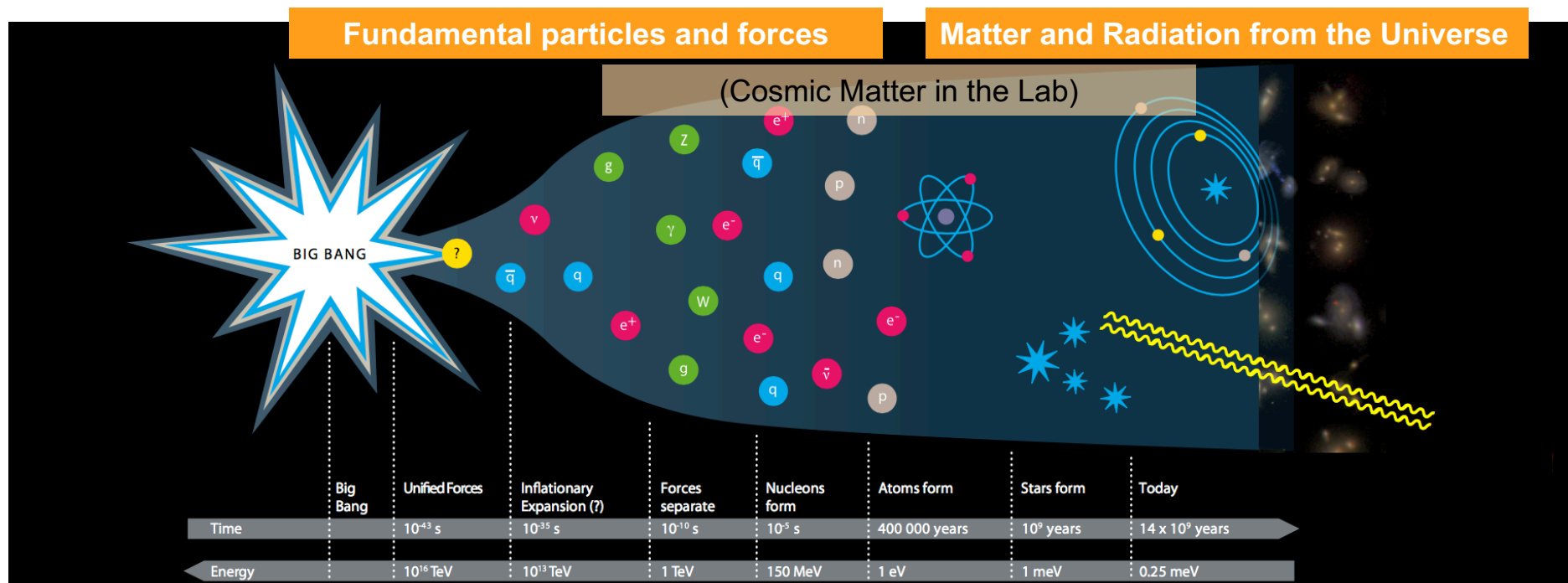


The Mission of the Program *Matter and the Universe*

In the words of the status report

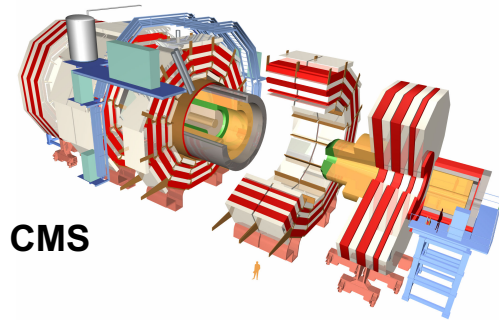
... understanding the most elementary building blocks of matter, their interactions, and [their] influence ... on the development of the universe.

Our picture ... is incomplete and partly inconsistent, and the entire MU program is dedicated to solving the related scientific challenges.



Science Drivers

Big open questions



CMS

Structure of the vacuum

Nature of the Higgs

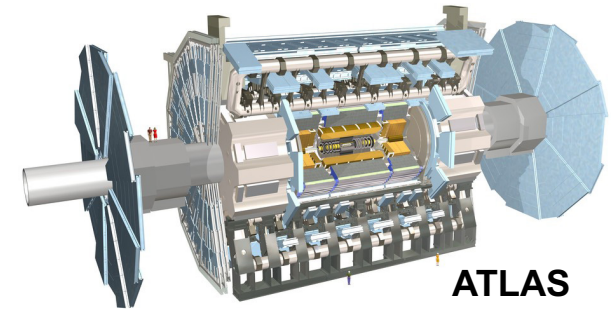
Theory beyond SM

Dark matter

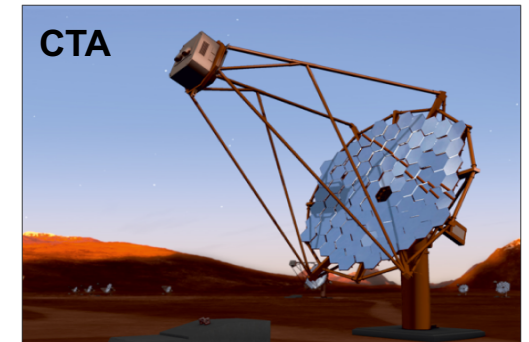
(Anti)Matter asymmetry

Neutrino properties

Cosmic accelerators

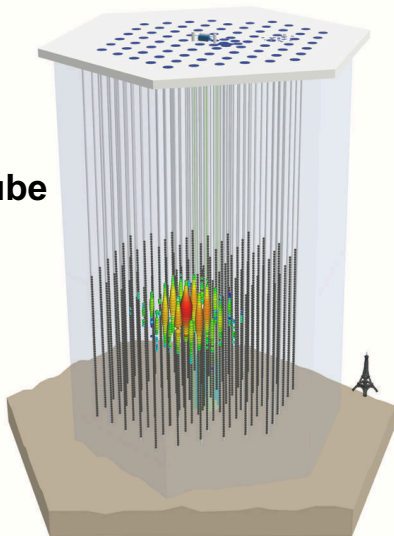


ATLAS

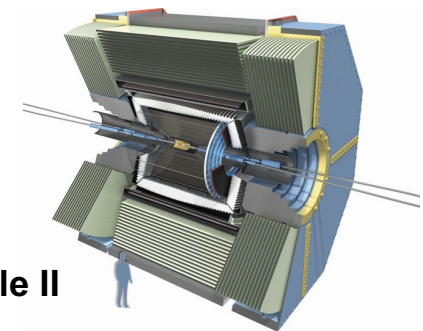


CTA

IceCube



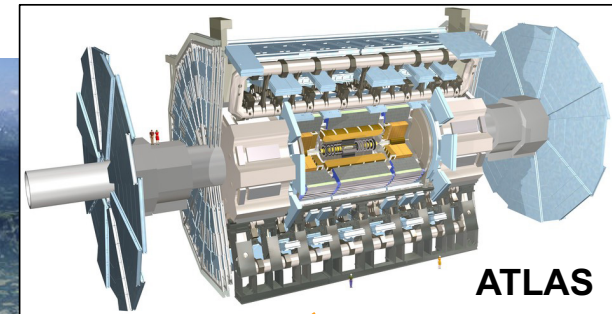
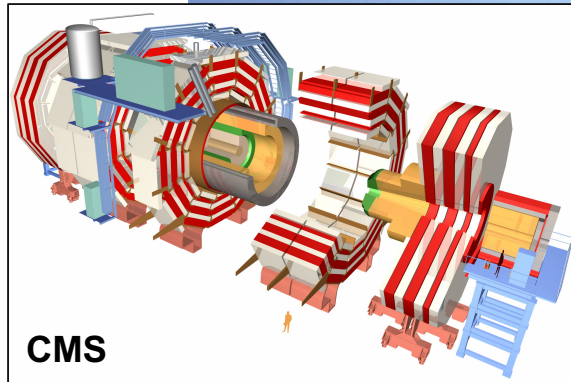
Theory



Belle II

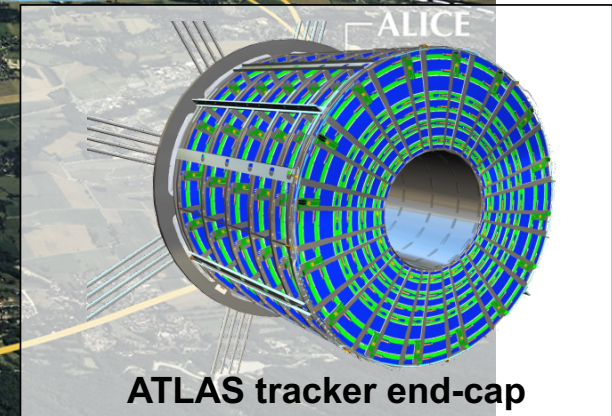
Flagship: The Large Hadron Collider LHC

Global priority number 1: experiments ATLAS+CMS



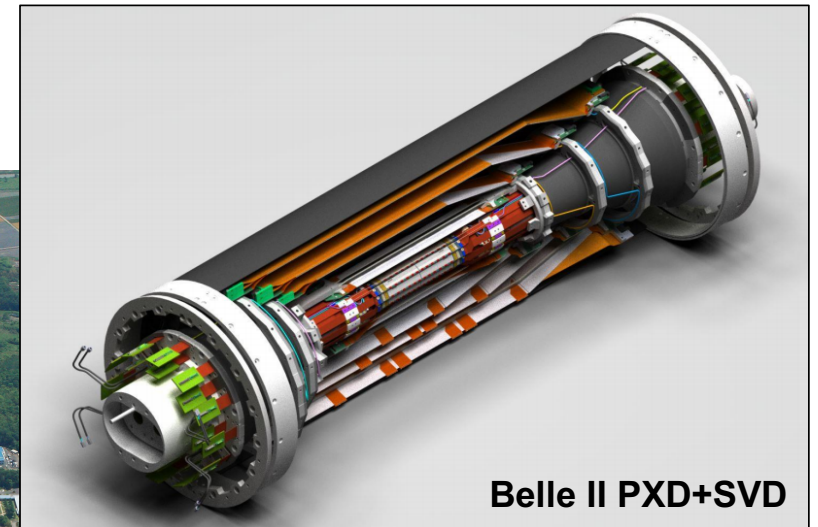
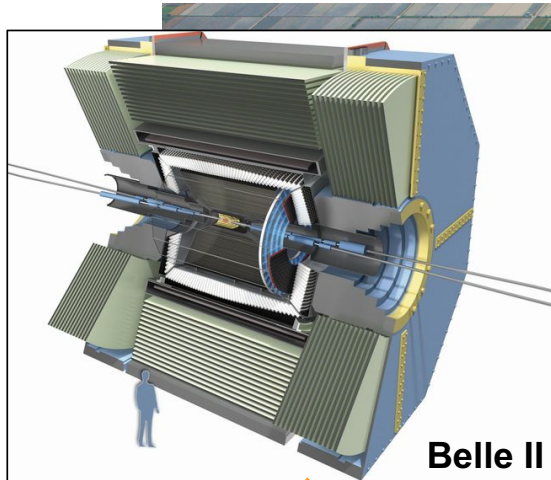
- Among the largest groups
- Management
- Operations and computing
- Physics analysis (SM, top, Higgs, new physics)
- Upgrade; facilitator for German contribution

27 km circumference
pp collisions at 13 TeV
Higgs discovery 2012
Searches for new physics
Upgrade to HL-LHC



Flagship: Belle II

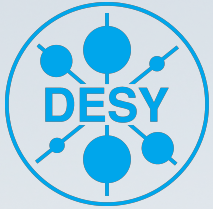
Highest precision at the Japanese SuperKEKB e^+e^- collider



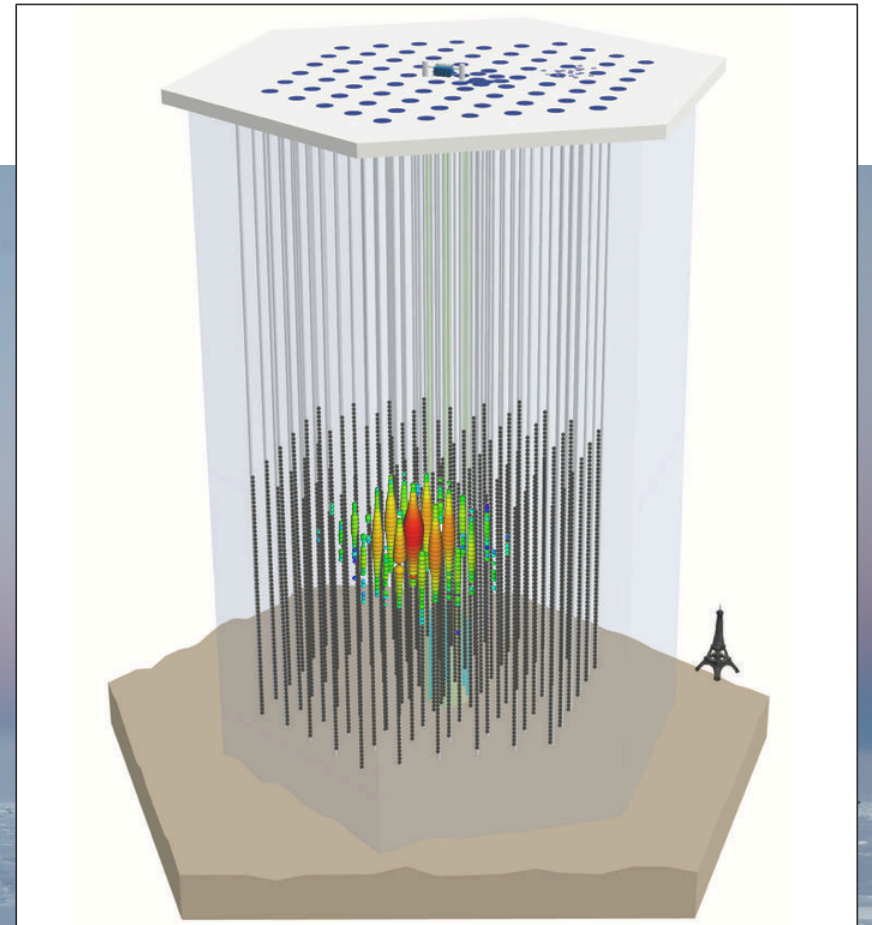
- Pixel vertex detector and infrastructure
- Management, collab. services, computing
- Physics analysis (SM, LFU, DM / axions / dark photons)
- Facilitator for German contribution

Flagship: IceCube

Neutrino astronomy at the south pole

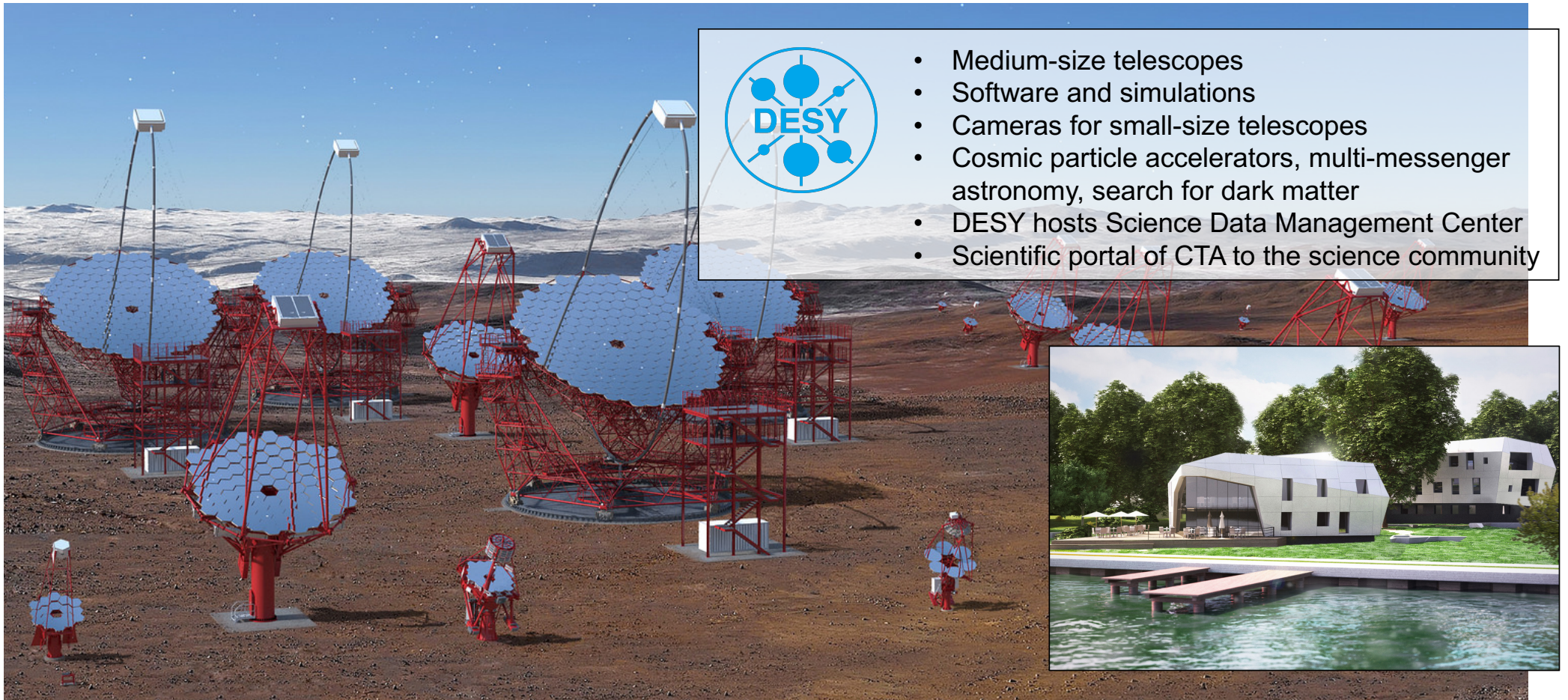


- Production of 25% of sensors
- TIER-1 data center
- Realtime pipeline
- Multi-wavelength follow-up observations
- Physics: Astrophysical neutrinos, multi-messenger astronomy, neutrino oscillations
- IceCube-Gen2 preparations



Flagship: Cherenkov Telescope Array CTA

The global future gamma-ray observatory – Europe's top priority in astroparticle physics



Matter and the Universe at DESY

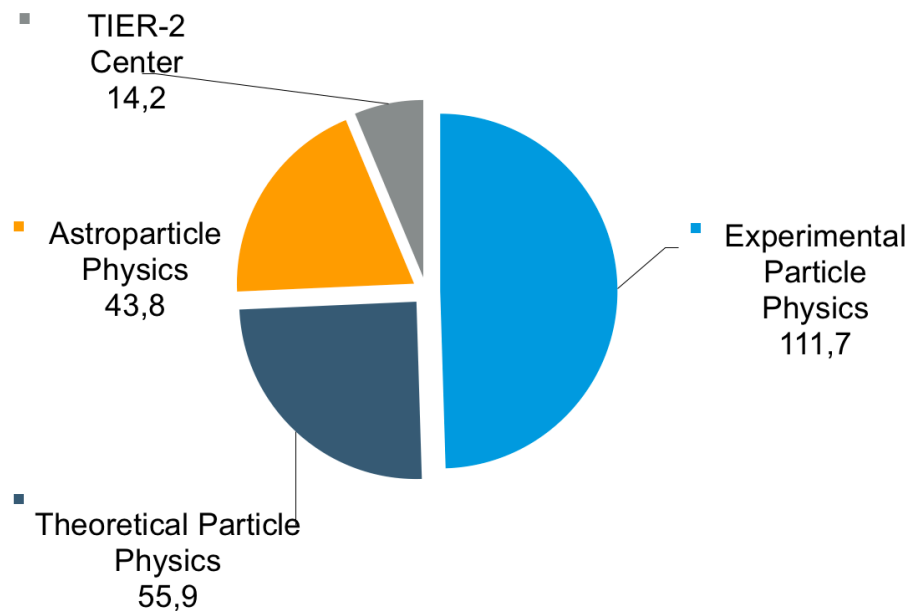
Core-funded plus third-party-funded scientists (FTE) without Ph.D. students

Core-financed costs (2016): 39.626 MEUR (plus TIER-2 Center with 5.564 MEUR)

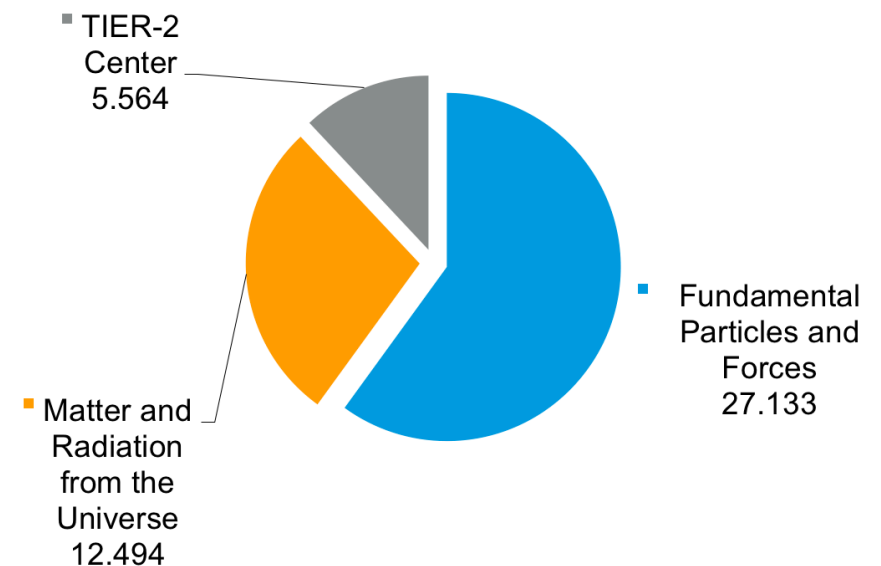
Third-party funding (2016): 4.438 MEUR

More than 100 Ph.D. students

FTEs (scientists without Ph.D. students, 2016)



Program core costs (MEUR, 2016)



Networking and Cooperation

In Germany, Europe, the world

In 2013-17:

- 10 common appointments with universities
- RWTH Aachen, HU Berlin, U Freiburg, U Hamburg, U Potsdam

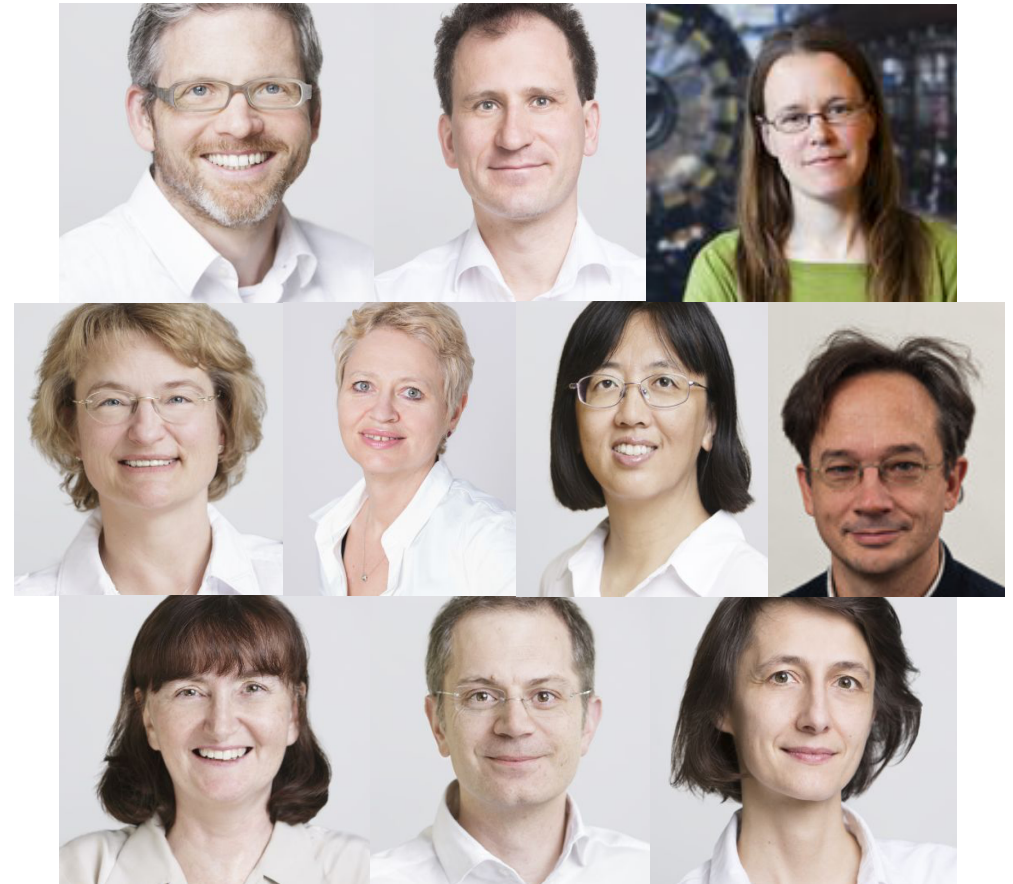
Additionally two leading scientists

- K. Peters (ATLAS), C. Schwanenberger (CMS)

Teaching also by other DESY staff members

- At numerous German and international universities
- Aachen, Antwerp, Berlin (HUB+FU), Cottbus, Dortmund, Dresden, Hamburg, Hannover, Heidelberg, Karlsruhe, Leipzig, Vienna, ...
- ... and at numerous summer schools and similar events.

Common appointments 2013-2017



D. Berge (HUB)

M. Kowalski (HUB)

K. Tackmann (UHH)

K. Borras (RWTH)

B. Heinemann (Freiburg)

H. Yan (Potsdam) J. Teschner (UHH)

E. Gallo (UHH)

C. Grojean (HUB)

G. Servant (UHH)

Cooperation Map

In Germany, Europe, the world

DESY is a strong collaboration partner in particle and astroparticle physics

Regionally:

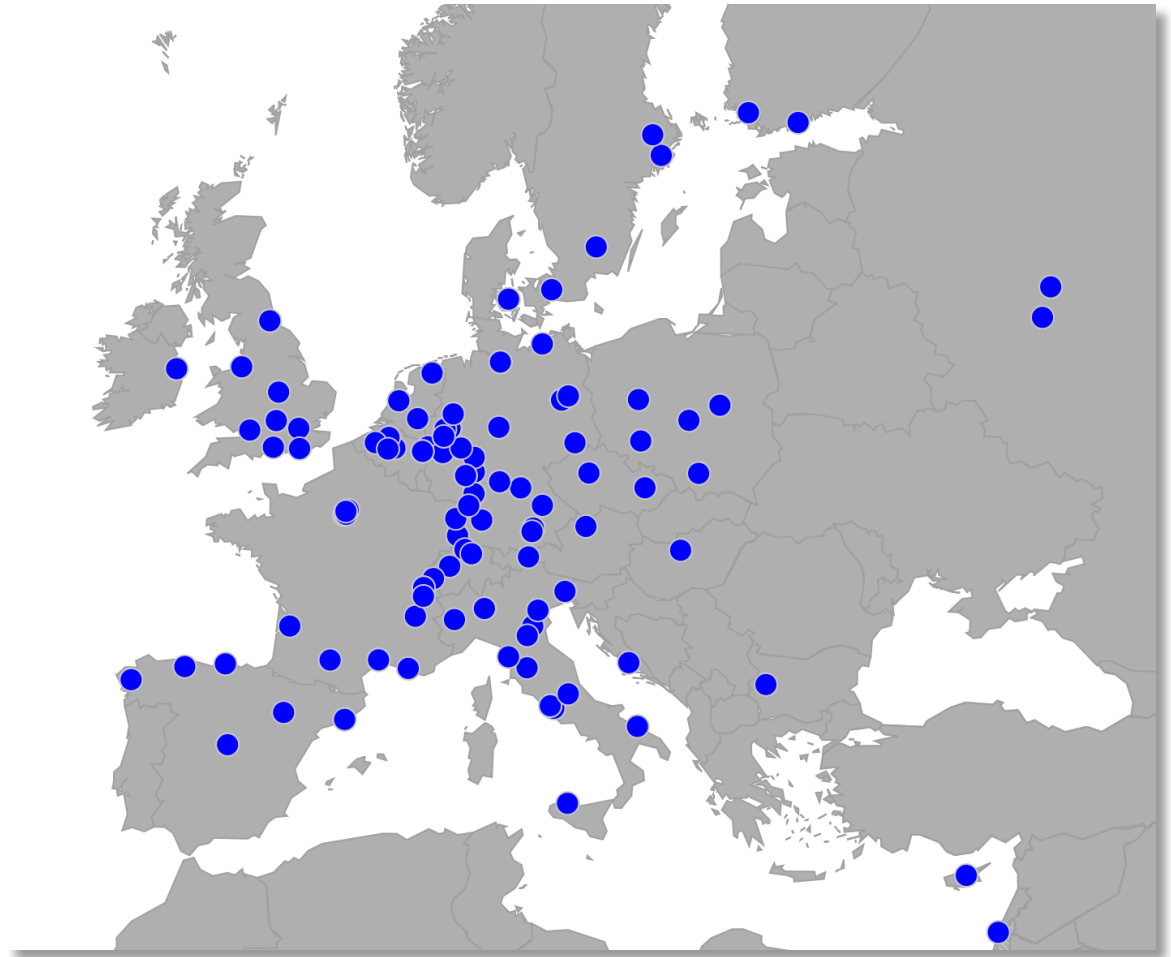
- Tight ties to local universities
- Proposal for Excellence Cluster “Quantum Universe”

Nationally:

- Hub for German communities
- Facilitator for international large-scale projects with massive German contribution
- Members of KET, KAT

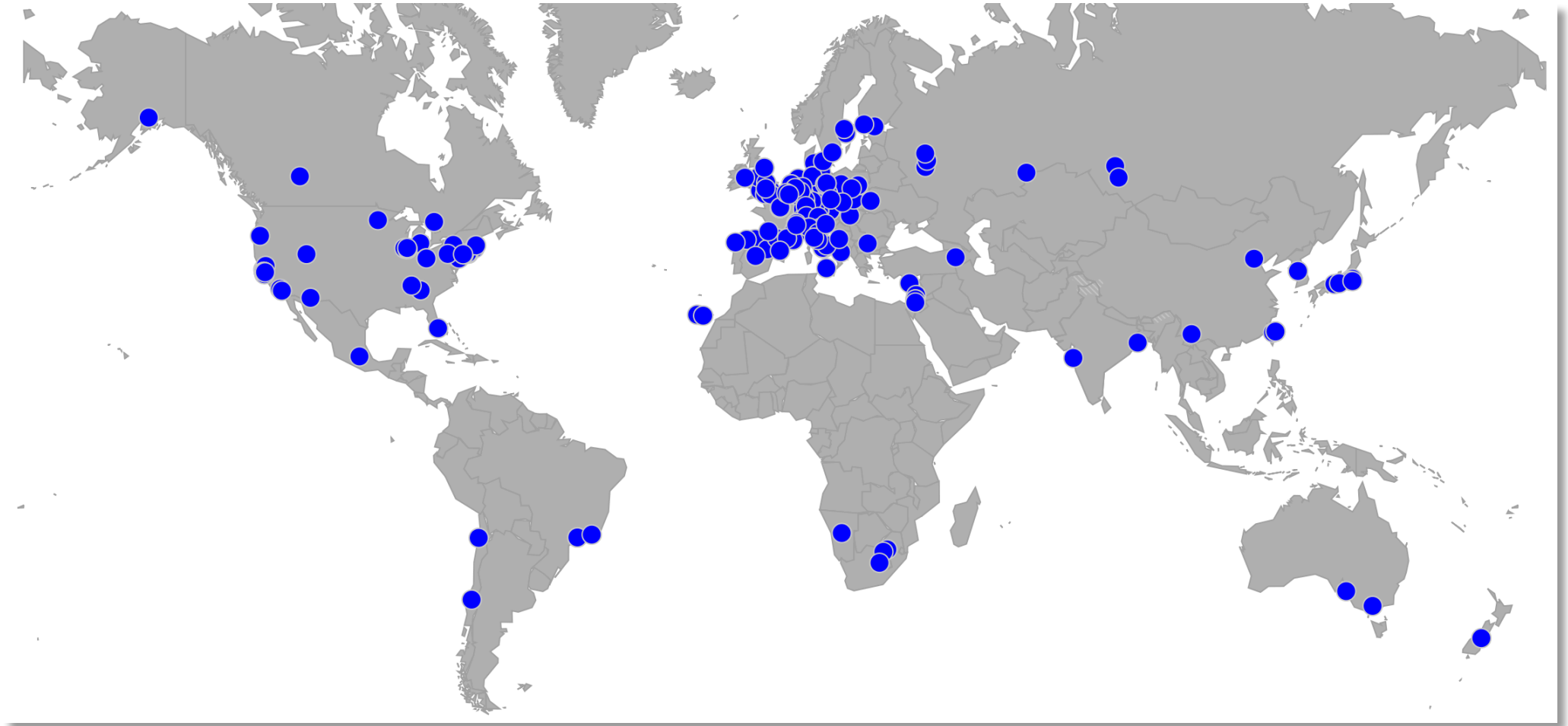
In Europe and globally:

- Collaboration with the large players in the fields
- CERN, KEK, Fermilab, SLAC, etc.
- Member of APPEC, ECFA, ICFA and of many review bodies



Cooperation Map: Important Partners

In Germany, Europe, the world



Talent Management

Aiming for the brightest talents

Summer students



Ph.D. students

- About 100 Ph.D. students in MU (30 dissertations / year)
- Universities of Hamburg and Berlin and many others.

Fellowship programmes

- Extremely competitive programmes
- About 10 (theory) and 20 (exp. particle physics) fellows / year

ERC grants:

- Starting grants: K. Schmidt-Hoberg (TPP, 2015), K. Tackmann (EPP, 2016), K. Lohwasser (EPP, 2017)
- Consolidator grants: A. Westphal (TPP, 2015), W. Winter (APP, 2015)

Young investigator groups granted in reporting period:

- Helmholtz Young Investigator Groups:
Anna Franckowiak, Torben Ferber, Sarah Heim, Abideh Jafari, Maria Aldaya Martin, Priscilla Pani, Elisa Pueschel
- Emmy Noether Groups:
Elli Pomoni, Frank Tackmann

Appointments to other universities

- E. Bernardini (Padova), A. Cakir (Istanbul), S.Choudhury (Bhopal), D. Dorigoni (Durham), O. Lebedev (Helsinki), K. Lohwasser (Sheffield), A.Nayak (Bhubaneswar), Y. Peters (Manchester), P. Schwaller (Mainz), Andreas Weiler (TU München)

Particle Physics Strategy

From the DESY 2030 strategy process

Explore the LHC and beyond

- Upgrade ATLAS and CMS for HL-LHC
- Prepare leading participation in future global collider project

Harvest at Belle II

- Data taking and analysis until ~2027

On-site experiment

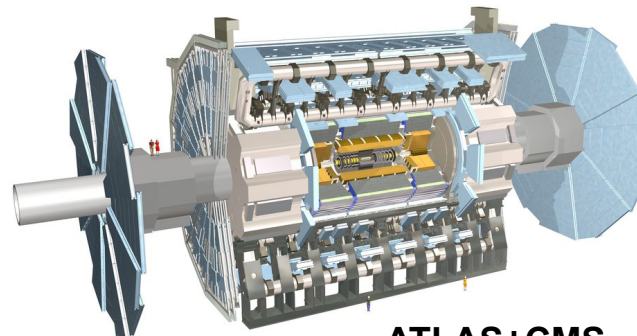
- Prepare a future on-site experiment after ALPS-II
- Detector R&D & testbeam operation

Theory:

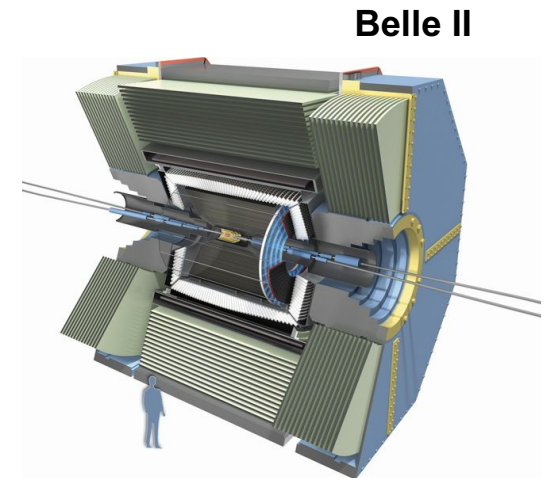
- Maintain broad spectrum of research topics and world-leading expertise

DESY as a “hub”:

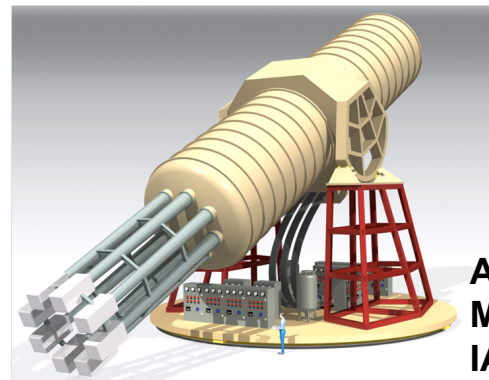
- Support projects with large German participation



ATLAS+CMS



Belle II



ALPS-II
MADMAX
IAXO



Strategy in Astroparticle Physics

Further strengthening the scientific impact

Gamma-ray astronomy

- Build, operate and use CTA; identify and drive prominent science topics
- Science exploitation of running experiments

Neutrino astronomy

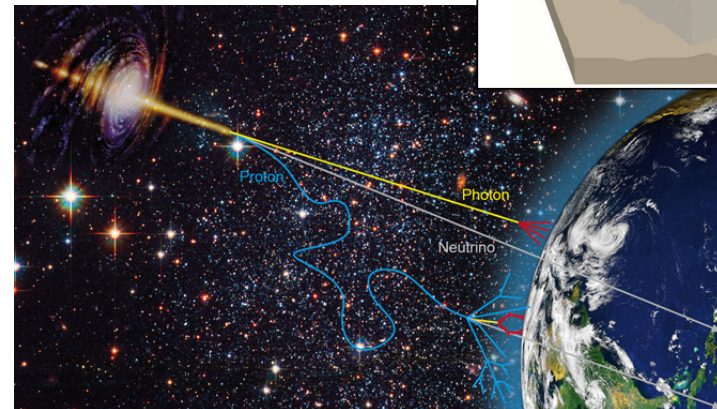
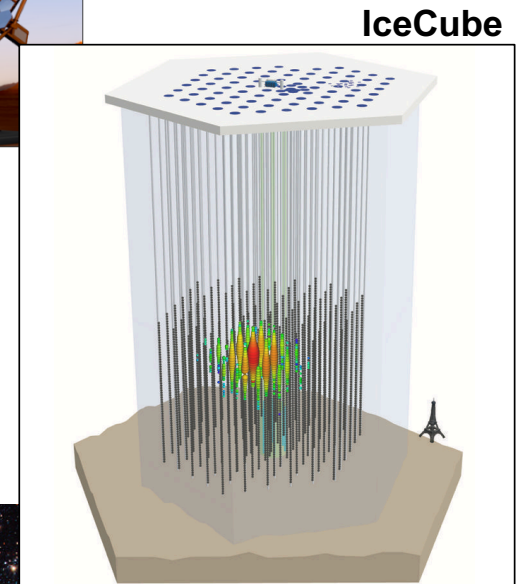
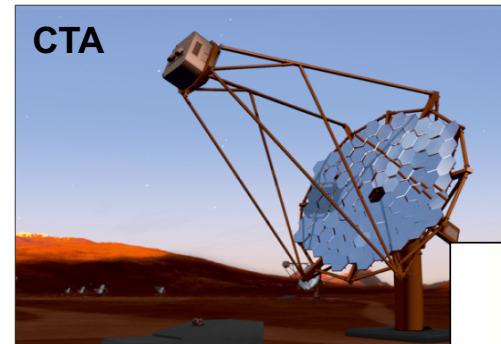
- Exploitation of IceCube (neutrino astronomy / neutrino physics)
- Drive the IceCube upgrade program towards IceCube-Gen2
- Expand towards radio detection of EHE cosmic neutrinos

Theoretical astroparticle physics

- Studies of particle acceleration and transport processes
- Modeling of sources and their emission

Multi-messenger astronomy and synergies

- Key role in real-time alert systems and optical follow-ups for gamma-ray and neutrino observatories
- Further develop synergies with neighboring fields: Dark Matter together with particle physics, neutrino physics, ...



Summary

Matter and the Universe at DESY

DESY is THE leading institute in *Matter and the Universe*

DESY is THE hub for particle and astroparticle physics in Germany and a strong cooperation partner in international projects

DESY has major roles in the leading experiments worldwide (ATLAS, Belle II, CMS, CTA, IceCube, ...)




We are preparing for the next “big thing”

We are attracting the best talents

We hold strategic memberships in the relevant national and international committees, shaping the future of particle and astroparticle physics

The Program *Matter and the Universe*

At the Helmholtz Center DESY

		Research Units		Matter		POF III	
Beate Heinemann		Experimental Particle Physics	Theoretical Particle Physics	Astroparticle Physics	Matter and the Universe	From Matter to Materials and Life	Matter and Technologies
					Fundamental Particles and Forces	Research on Matter at LSF	Accelerator Research and Development
Georg Weiglein					Cosmic Matter in the Laboratory	Facility Topic: Photon Sources	Detector Technologies and Systems
					Matter and Radiation from the Universe	Facility Topic: Neutron Sources	
Marek Kowalski					TIER-2 Center	Facility Topic: Ion Sources	
						Facility Topic: Highest Magnetic Fields	